

SHORT-FINNED PILOT WHALE (*Globicephala macrorhynchus*): Hawaii Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Short-finned pilot whales are found in all oceans, primarily in tropical and warm-temperate waters. Summer/fall shipboard surveys of the waters within the U.S. Exclusive Economic Zone (EEZ) of the Hawaiian Islands resulted in 25 sightings in 2002, 36 in 2010, and 35 in 2017 including a higher frequency of encounters near shore within the Northwestern Hawaiian Islands (Figure 1; Barlow 2006, Bradford *et al.* 2017, Yano *et al.* 2018).

Two forms of short-finned pilot whales have been identified in Japanese waters based on pigmentation patterns and differences in the shape of the heads of adult males (Kasuya *et al.* 1988). Genetic analysis of samples from throughout the global range of short-finned pilot whales suggest three types within the species, an Atlantic type, a western/central Pacific and Indian Ocean (Naisa) type, and an eastern tropical Pacific and northern Japan (Shiho) type. Significant differentiation in mtDNA control region sequences further suggest that the three forms represent two subspecies, the Shiho short-finned pilot whale and the Naisa short-finned pilot whale, with evidence of further divergence among the Naisa types in the Atlantic and Pacific (Van Cise *et al.* 2019). The pilot whales in Hawaiian waters are of the Naisa type. The Shiho and Naisa forms appear also to be distinguishable based on the acoustic features of their whistle and burst-pulse sounds, providing further evidence for divergence between these subspecies (Van Cise *et al.* 2017).

Photo-identification, telemetry, acoustic, and genetic studies suggest that at least two demographically-independent populations of short-finned pilot whales reside in Hawaiian waters. Resighting and social network analyses of individuals photographed off Hawaii Island suggest the occurrence of one large and several smaller social clusters, with some individuals within the smaller social clusters commonly resighted off Hawaii Island (Mahaffy *et al.* 2015). Further, two groups of 14 individuals have been seen at Hawaii and elsewhere in the main Hawaiian Islands, one off Oahu and the other off Kauai, indicating some degree of connectivity within the main Hawaiian Islands (MHI). Satellite telemetry data from over 60 individuals tagged throughout the main Hawaiian Islands also support the occurrence of at least two populations (Baird 2016, Oleson *et al.* 2013). An assessment of foraging hotspots off Hawaii Island revealed tight association between satellite-tagged short-finned pilot whales and the 1000-2500m depth range (Abecassis *et al.* 2015). More recently, Van Cise *et al.* (2017) used nuclear SNPs to assess population structure within Hawaii short-finned pilot whales and found evidence for an island-associated population in the MHI. Although there was some support for separation of short-finned pilot whales in the northwestern Hawaiian Islands (NWHI) from other pelagic animals, additional genetic samples may be required to test this separation further. In addition, genetic data combined with social affiliation and habitat associations suggest the MHI population is further divided into social groups, and these groups may even rise to the level of demographic independence between those found primarily near Hawaii Island and those near Oahu and Kauai (Van Cise *et al.* 2017a). Differences in the acoustic features of short-finned pilot whale social clusters recorded within the MHI further supports the existence of several DIPs within the MHI (Van Cise *et al.* 2017b). Formal assessment of demographic independence is ongoing, but division of this population into a separate island-associated stock may be warranted in the future.

For the Marine Mammal Protection Act (MMPA) stock assessment reports, short-finned pilot whales within the Pacific U.S. EEZ are divided into two discrete, non-contiguous areas: 1) Hawaiian waters (this report), and 2)

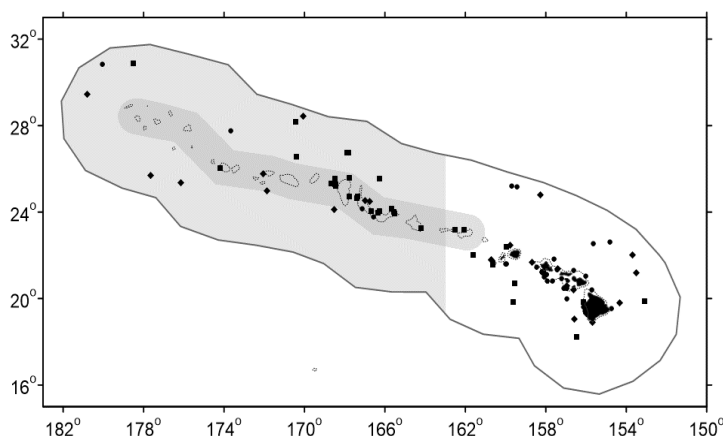


Figure 1. Short-finned pilot whale sighting locations during the 2002 (diamonds), 2010 (circles), and 2017 (squares) shipboard surveys of U.S. EEZ waters surrounding the Hawaiian Islands (Barlow 2006, Bradford *et al.* 2017, Yano *et al.* 2018). Outer solid line represents approximate boundary of survey area and U.S. EEZ. Gray shading indicates area of Papahānaumokuākea Marine National Monument with the lighter gray shading denoting the full 2016 Expansion area. Dotted line represents the 1000 m isobath.

waters off California, Oregon and Washington. The Hawaii stock includes animals found both within the Hawaiian Islands EEZ and in adjacent high seas waters. The status of the Hawaii stock is evaluated based on abundance, distribution, and human-caused impacts within the Hawaiian Islands EEZ, as such data are largely lacking for high seas waters (NMFS 2005).

POPULATION SIZE

Encounter data from shipboard line-transect surveys of the entire Hawaiian Islands EEZ was recently reevaluated, resulting in updated model-based abundance estimates of short-finned pilot whales in the Hawaii EEZ (Becker *et al.* 2021; Table 1).

Table 1. Line-transect abundance estimates for short-finned pilot whales derived from surveys of the entire Hawaii EEZ in 2002, 2010, and 2017 (Becker *et al.* 2021).

Year	Model-based abundance	CV	95% Confidence Limits
2017	12,607	0.18	8,826-18,008
2010	15,343	0.17	11,039-21,326
2002	15,198	0.17	10,900-21,191

Sighting data from 2002 to 2017 within the Hawaii EEZ were used to derive habitat-based models of animal density for the overall period. The models were then used to predict density and abundance for each survey year based on the environmental conditions within that year (see Forney *et al.* 2015, Becker *et al.* 2016). The modeling framework incorporated Beaufort-specific trackline detection probabilities for short-finned pilot whales from Barlow *et al.* (2015). Bradford *et al.* (2021) produced design-based abundance estimates for short-finned pilot whales for each survey year that can be used as a point of comparison to the model-based estimates. While on average the estimates are broadly similar between the two approaches, the annual design-based estimates show much greater variability between years than do the model-based estimates (Figure 2). The model-based approach reduces variability through explicit examination of habitat relationships across the full dataset, while the design-based approach evaluates encounter data for each year separately and thus is more susceptible to the effects of encounter rate variation. Model based-estimates are based on the implicit assumption that changes in abundance are attributed to environmental variability alone. There are insufficient data to explicitly incorporate a trend term into the model due to the insufficient sample size to test for temporal effects. Despite not fully accounting for inter-annual variation in total abundance, the model-based estimates are considered the best available estimate for each survey year. Previously published design-based estimates for the Hawaii EEZ from 2002 and 2010 surveys (e.g. Barlow 2006, Bradford *et al.* 2017) used a subset of the dataset used by Becker *et al.* (2021) and Bradford *et al.* (2021) to derive line-transect parameters, such that these estimates have been superseded by the estimates presented here. The best estimate of abundance is based on the 2017 survey, or 12,607 (CV=0.18).

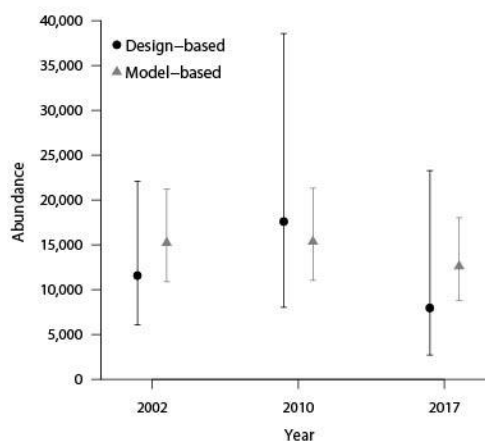


Figure 2. Comparison of design-based (circles, Bradford *et al. in review*) and model-based (triangles, Becker *et al. in review*) estimates of abundance for short-finned pilot whales for each survey year (2002, 2010, 2017).

Minimum Population Estimate

The minimum population size is calculated as the lower 20th percentile of the log-normal distribution (Barlow *et al.* 1995) of the 2010 abundance estimate for the Hawaiian Islands EEZ or 10,847 short-finned pilot whales.

Current Population Trend

The model-based abundance estimates for short-finned pilot whales provided by Becker *et al.* (2021) do not explicitly allow for examination of population trend other than that driven by environmental factors. Model-based examination of short-finned pilot whale population trends including sighting data beyond the Hawaii EEZ will be required to assess abundance trends for this stock.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

No data are available on current or maximum net productivity rate.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for the Hawaii short-finned pilot whale stock is calculated as the minimum population estimate (10,847) times one half the default maximum net growth rate for cetaceans ($\frac{1}{2}$ of 4%) times a recovery factor of 0.40 (for a species of unknown status with a Hawaiian Islands EEZ fishery mortality and serious injury rate $CV > 0.80$; Wade and Angliss 1997), resulting in a PBR of 87 short-finned pilot whales per year.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fishery Information

Information on fishery-related mortality of cetaceans in Hawaiian waters is limited, but the gear types used in Hawaiian fisheries are responsible for marine mammal mortality and serious injury in other fisheries throughout U.S. waters. Entanglement in gillnets and hooking or entanglement in various hook and line fisheries have been reported for small cetaceans in Hawaii (Nitta & Henderson, 1993). Short-finned pilot whales have been observed with fishing gear trailing from their mouths, though the specific gear types have not been identified (Baird 2016). In 2014, a short-finned pilot whale was found stranded on Oahu with large amounts of debris in its stomach, including approximately 20 lbs. of fishing line, nets, and plastic drogues, though this gear was judged not to be the cause of death (Bradford and Lyman 2018). In 2017, two short-finned pilot whales stranded together as part of a mass stranding event on Kauai. One of the whales had 12-15 lbs of nylon line and plastic present within its forestomach and the other has scarring on the upper right jaw consistent with previous fisheries interaction, though in neither case were these findings considered to be related to the cause of death (Bradford and Lyman 2019). No estimates of human-caused mortality or serious injury are currently available for nearshore hook and line or gillnet fisheries because these fisheries are not monitored for protected species bycatch.

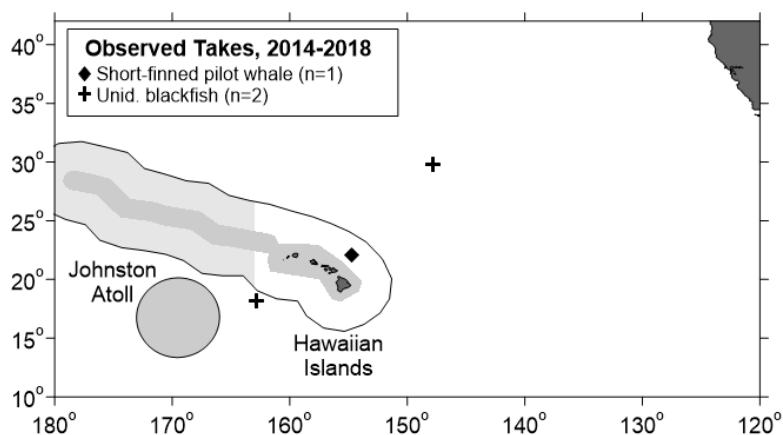


Figure 3. Locations of short-finned pilot whale takes (filled diamonds) and possible takes of this species (crosses) in Hawaii-based longline fisheries, 2014-2018. Solid lines represent the U. S. EEZ. Gray shading notes areas closed to longline fishing with the PMNM Expansion area closed since August 2016.

Table 2. Summary of available information on incidental mortality and serious injury of short-finned pilot whales (Hawaii stock) and including those presumed to be short-finned pilot whales based on assignment of unidentified blackfish to this species in commercial longline fisheries, within and outside of the U.S. EEZs (McCracken 2019). Mean annual takes are based on 2014-2018 data unless otherwise indicated. Information on all observed takes (T) and combined mortality events & serious injuries (MSI) is included. Total takes were prorated to deaths, serious injuries, and non-serious injuries based on the observed proportions of each outcome. Unidentified blackfish are pro-rated as either false killer whales or short-finned pilot whales according to their distance from shore (McCracken 2010). CVs are estimated based on the combination of annual short-finned pilot whale and blackfish variances and do not incorporate additional uncertainty introduced by prorating the unidentified blackfish.

Fishery Name	Year	Data Type	Percent Observer Coverage	Observed total interactions (T) and mortality events, and serious injuries (MSI), and total estimated mortality and serious injury (M&SI) of short-finned pilot whales (GM)			
				Outside U.S. EEZs		Hawaiian EEZ	
				Obs. GM T/MSI	Estimated M&SI (CV)	Obs. GM T/MSI	Estimated M&SI (CV)
				Obs. UB T/MSI		Obs. UB T/MSI	
Hawaii-based deep-set longline fishery	2014	Observer data	21%	0 0	0 (-)	0 0	0 (-)
	2015		21%	0 1/1†	0.7 (0.9)	1/1 0	4.3 (0.9)
	2016		20%	0 0	0 (-)	0 0	0 (-)
	2017		20%	0 0	0 (-)	0 0	0 (-)
	2018		18%	0 1/1	0.8 (0.8)	0 0	0 (-)
Mean Estimated Annual Take (CV)					0.3 (0.9)		0.9 (1.1)
Hawaii-based shallow-set longline fishery	2014	Observer data	100%	0 0	0	0 0	0
	2015		100%	0 0	0	0 0	0
	2016		100%	0 0	0	0 0	0
	2017		100%	0 0	0	0 0	0
	2018		100%	0 0	0	0 0	0
Mean Annual Takes (100% coverage)					0		0
Minimum total annual takes within U.S. EEZ							0.9 (1.1)

[†] Injury status could not be determined based on information collected by the observer. Injury status is prorated (see text).

There are currently two distinct longline fisheries based in Hawaii: a deep-set longline (DSL) fishery that targets primarily tunas, and a shallow-set longline fishery (SSL) targeting swordfish. Both fisheries operate within U.S. waters and on the high seas, but are prohibited from operating within the Papahānaumokuākea Marine National Monument, a region that extends 50 nmi from shore around the Northwestern Hawaiian Islands, and within the Longline Exclusion Area, a region extending 25-75 nmi from shore around the main Hawaiian Islands. Commercial fishing has also been banned within the expanded PMNM since August 2016. Between 2014 and 2018, no short-finned pilot whales were observed hooked or entangled in the SSL fishery (100% observer coverage), and one was observed taken in the DSL fishery (18-21% observer coverage) (Figure 3, Bradford 2018a, 2018b, 2020, Bradford and Forney 2017, McCracken 2019), inside the Hawaiian Islands EEZ. Based on an evaluation of the observer's description of the interaction and following the most recently developed criteria for assessing serious injury in marine mammals (NMFS 2012), this short-finned pilot whale was considered seriously injured. Two additional unidentified "blackfish" (unidentified cetaceans known to be either false killer whales or short-finned pilot whales) were taken during 2014-2018 (Bradford 2018a, 2018b, 2020, Bradford and Forney 2017), both within the DSL fishery. Both of the DSL interactions, occurred outside the Hawaii EEZ, with one considered seriously injured, and one whose injury status could not be determined based on the information provided by the observer. Unidentified blackfish are prorated to each stock based on distance from shore (McCracken 2010). The distance-from-shore model was chosen following consultation with the Pacific Scientific Review Group, based on the model's performance and simplicity relative to a number of other more complicated models with similar output (McCracken 2010). Proration of unidentified blackfish takes introduces unquantified uncertainty into the bycatch estimates, but until all animals taken can be identified to species (e.g., photos, tissue samples), this approach ensures that potential impacts to all stocks are assessed. Average 5-yr estimates of annual mortality and serious injury for 2014-2018 are 1.5 (CV = 0.9) short-finned pilot whales outside of U.S. EEZs and 0.9 (CV = 1.1) within the Hawaiian Islands EEZ (Table 2). Four additional unidentified cetaceans were taken in the DSL fishery, some of which may have been short-finned pilot whales.

STATUS OF STOCK

The Hawaii stock of short-finned pilot whales is not considered strategic under the 1994 amendments to the MMPA. The status of short-finned pilot whales in Hawaiian waters relative to OSP is unknown, and there are insufficient data to evaluate trends in abundance. Short-finned pilot whales are not listed as “threatened” or “endangered” under the Endangered Species Act (1973), nor designated as “depleted” under the MMPA. The estimated rate of mortality and serious injury within the Hawaiian Islands EEZ (0.9 animals per year) is less than the PBR (87). Based on the available data, which indicate total fishery-related takes are less than 10% of PBR, the total fishery mortality and serious injury for short-finned pilot whales can be considered to be insignificant and approaching zero. Two short-finned pilot whales were found stranded in separate incidents following Navy sonar training exercises in Hawaii in 2014 (Bradford and Lyman 2018). Examination of whales could not conclusively link these stranding to use of sonar, though other blackfish have shown sensitivity to sonar training events in Hawaii waters (Southall *et al.* 2006) and elsewhere (Brownell *et al.* 2009).

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